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COMBAT IDENTIFICATION SYSTEMS COMO INTEGRATED AIR DEFENSE MODEL EVALUATION (CISE) STUDY

FEBRUARY 1989

PREPARED BY
FORCE SYSTEMS DIRECTORATE

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
The purpose of the CISE Study was to install, test, and evaluate the Combat Identification Systems COMO Integrated Air Defense (CISCIAD) Model with the goal of replacing the COMO Integrated Air Defense (CIAD) Model at the US Army Concepts Analysis Agency (CAA). The basic approach was to execute a series of identical scenarios with both models and compare output results. The CISCIAD Model was found to contain numerous errors in the air-to-air logic, and the decision was made to defer further consideration at CAA until a later date when the model has reached a better level of maturity. This study report documents the tests performed and the corrections made to the model during the course of the study.

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COMBAT IDENTIFICATION SYSTEMS COMO INTEGRATED AIR DEFENSE MODEL EVALUATION (CISE) STUDY

February 1989

Prepared by

FORCE SYSTEMS DIRECTORATE

This document was prepared as part of an internal CAA project.

	COMBAT IDENTIFICATION SYSTEMS COMO INTEGRATED AIR DEFENSE MODEL EVALUATION (CISE) STUDY	STUDY SUMMARY CAA-SR-89-3
CAA		

THE REASON FOR PERFORMING THE STUDY was to install, test, and evaluate the Combat Identification Systems COMO Integrated Air Defense (CISCIAD) model with the goal of replacing the COMO Integrated Air Defense (CIAD) Model at the US Army Concepts Analysis Agency (CAA). The CISCIAD Model is a modified version of the CIAD Model which has been in use at CAA since 1985. A modification contract was let to Veda, Incorporated in February 1986 by the US Army TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR) for the purpose of updating the CIAD Model with the capability to simulate higher resolution command, control, and communications, airspace management, and identification, friend or foe. The contract was completed in June 1987.

THE PRINCIPAL FINDINGS are as follows:

(1) The CISCIAD Model was successfully installed on CAA's VAX 8600 computer; however, the initial release of the model to CAA (October 1987) contained errors in the contractor-added software. The contractor and TRAC-WSMR continued to fix these problems as well as make other improvements to the basic model after releasing it to CAA. Since the model was in such a turbulent state, the CISE Study was put on hold until TRAC-WSMR could release a final version. TRAC-WSMR released a final version to CAA in July 1988.

(2) Comparisons of test results between the CISCIAD and CIAD Models revealed numerous discrepancies, mainly in the air-to-air portion of the models. However, tests of the surface-to-air and air-to-surface logic (without utilizing the new CISCIAD Model features) produced fairly similar results between the two models. The fact that the CISCIAD Model was developed from an earlier version of the CIAD Model than the one in use at CAA is the cause of most of the differences discovered.

(3) At the time of this report, the decision was made to defer further consideration of the CISCIAD Model at CAA until a later date when the model has reached a better level of maturity. The development of CISCIAD was a highly ambitious effort which added a large number of complex features to an already complex model. Common to software development efforts of this magnitude is the need for an extended test and debug period. The proponent is continuing efforts to refine CISCIAD, and the model should, at some time in the future, prove to be a powerful tool for supporting air defense analyses. When the CISCIAD Model matures to a more reasonable level of reliability, then CAA should consider again acquiring it for evaluation.

THE MAIN ASSUMPTION AND LIMITATIONS were that the study was not designed to be an exhaustive analysis nor a verification of the CISCIAD Model. Since the model was accepted by TRAC-WSMR, the technical functioning of the modifications made by the contractor was assumed to be correct. The study only examined the CISCIAD Model output data for reasonableness as compared to the CIAD Model results.

THE SCOPE OF THE STUDY included the installation of the CISCIAD Model on CAA's VAX 8600 computer, a statistical comparison of output between the CISCIAD and CIAD Models, given the same conditions, and an evaluation of the new features of the model for producing reasonable results when compared to a similar scenario using the CIAD Model.

THE STUDY OBJECTIVES were to:

(1) Install and operate the CISCIAD Model on CAA's VAX 8600 computer.

(2) Determine whether the output results from the CISCIAD and CIAD Models are similar (within confidence intervals) given the same conditions.

(3) Evaluate the capability of the CISCIAD Model to produce reasonable results when utilizing the new features of command, control, and communications, airspace management, and identification, friend or foe.

THE BASIC APPROACH was to evaluate the CISCIAD Model in three steps:

(1) Perform comparison tests between the CISCIAD and CIAD Models using one weapon system at a time.

(2) Conduct a statistical analysis using a small identical scenario on both models, vary the input parameters, and compare output results using two-sample t-tests.

(3) Execute a series of comparison runs using a large scenario which utilizes the new features of the CISCIAD Model and observe the effects on the results of the two models.

THE STUDY SPONSOR was the Director, US Army Concepts Analysis Agency.

THE STUDY EFFORT was performed by Diane L. Buescher, Richard W. Lennox, Jr., Lorie A. Latchford, Pamela J. Roberts, and Tanya E. Peltz, Force Systems Directorate, US Army Concepts Analysis Agency.

COMMENTS AND QUESTIONS may be addressed to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSC, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

Tear-out copies of this synopsis are at back cover.

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EVALUATION (CISE) STUDY

CHAPTER 1

INTRODUCTION

1-1. BACKGROUND

a. This effort is a follow-on to the US Army Concepts Analysis Agency
(CAA) Air Defense Models Modification (ADM2) Study (completed in September
1986). ADM2 had an objective of obtaining a theater-level air defense model
for CAA. The "COMO III Integrated Air Defense Model with Command and
Control" (CIAD) was obtained from the US Air Force Operational Test and
Evaluation Center (AFOTEC) to be used in the interim while a contract was let
to upgrade the CIAD Model. The upgrade was to include the capability to
simulate higher resolution command, control, and communications (C3),
airspace management, and identification, friend or foe (IFF).

b. The modification contract was initiated and funded by the US Army
TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR). CAA
assisted in developing the statement of work and provided minimal assistance
in monitoring the contract. The contract commenced in February 1986 by Veda,
Incorporated with much of the effort subcontracted to SRS Technologies. The
modified model, called the Combat Identification Systems COMO Integrated Air
Defense (CISCIAD) Model, was completed by the contractor and accepted by
TRAC-WSMR in June 1987. CAA obtained a copy and began installation of the
CISCIAD Model in October 1987. A brief description of the COMO modeling
system is contained in Appendix D.

1-2. PURPOSE. The purpose of the study was to install, test, and make
operational at CAA the CISCIAD Model and to evaluate the model by comparing
output results to the CIAD Model. The plan was to replace the CIAD Model
with the CISCIAD Model when it became operational.

1-3. OBJECTIVES. The study objectives were to:

a. Install and operate the CISCIAD Model on CAA's VAX 8600 computer.

b. Determine whether the output results from the CISCIAD and CIAD Models
are similar (within confidence intervals), given the same conditions.

c. Evaluate the capability of the CISCIAD Model to produce reasonable
results when utilizing the new features of C3, airspace management and IFF.

1-4. SCOPE. The scope of the study included the installation of the CISCIAD
Model on CAA's VAX 8600 computer, a statistical comparison of output between
the CISCIAD and CIAD Models, given the same conditions, and an evaluation of
the new features of the model for producing reasonable results when compared
to a similar scenario using the CIAD Model.

1-5. ASSUMPTIONS AND LIMITATIONS. This study was not designed to be an exhaustive analysis nor a verification of the CISCIAD Model. Since the model was accepted by TRAC-WSMR, the technical functioning of the modifications made by the contractor was assumed to be correct. This study only examined the CISCIAD Model output data for reasonableness as compared to the CIAD Model results.

1-6. SUMMARY OF CONTRACTOR MODIFICATIONS. Table 1-1 compares the new contractor-added features in the CISCIAD Model with the old features in the CIAD Model.

Table 1-1. Summary of Contractor Modifications

Feature	CIAD Model	CISCIAD Model
Command, control, and communications	Coordinates fire of high-to-medium altitude air defense (HIMAD) units and intercepting aircraft. Only one level of command and control.	Added ability to hold HIMAD fire until command center has received information and identified target. Capable of simulating up to five levels of command.
Identification, friend or foe	Simulates identifying target with random draw against input probabilities of correct identification for Blue and Red targets.	Simulates actual identification devices for both ground units and aircraft.
Airspace management	Single weapons control input parameter for each ground unit covers entire airspace.	Capability to define airspace volumes with different weapons control orders in effect. Can specify safe passage corridors for Blue interceptor flight.
Non-line-of-sight weapon	Does not simulate.	New generic weapon added.
Air defense artillery weapon	Can be simulated in more detail with the HIMAD weapon but cannot simulate gun systems.	New generic weapon added that can simulate either gun or surface-to-air missile systems.
Helicopters	Does not simulate.	Modification of the Red and Blue aircraft code to simulate helicopters used primarily as transiting aircraft and identification targets.
Jamming	Simulates broadband noise jamming.	Added features to turn jamming on at preplanned flight path locations or when detected by radars.

1-7. APPROACH. The approach was to install the CISCIAD Model on CAA's VAX 8600 computer and to evaluate the model in three steps. The first step was to perform comparison tests between the CISCIAD and CIAD Models using one weapon system at a time. The second step involved a statistical analysis using a small identical scenario for both models and comparing the output results using two sample t-tests. In both the first two steps, the new features of the CISCIAD Model were disabled in order to provide a similar scenario. Both Blue defensive and Red offensive systems were varied by either including or excluding classes of systems in the runs. The purpose of these comparisons was to ensure that the contractor preserved the capability of the CISCIAD Model to function as the CIAD Model since the goal was to replace it. The final phase of the evaluation was to perform comparison runs using a large scenario which utilized the new features of C^3, airspace management, and IFF in the CISCIAD Model to observe the effects on the results.

CHAPTER 2

MODEL COMPARISON TESTS

2-1. INTRODUCTION. This chapter contains a description of the comparison tests performed on the two models, a discussion of the results of those tests, and a summarization of the code corrections and updates made by CAA to the CISCIAD Model.

2-2. APPROACH. The approach was to conduct comparison tests between the two models using one weapon system at a time without utilizing the new features of the CISCIAD Model. The purpose of these tests was to ensure that each weapon system was operating similarly in both models and to help identify the source of discrepancies if they existed.

2-3. SCENARIO

a. A test scenario was designed that was large enough to exercise the model's capabilities while still producing manageable computer run times. The scenario is illustrated in Figure 2-1. The 60-minute air raid consisted of 30 Red defense suppression aircraft targeting PATRIOT and HAWK fire units followed by 24 escort fighters accompanying 18 bombers attacking the two rear airbases (AIRR and AIRB). Aircraft flew in formation sizes of three, at 200 meters per second and at altitudes of 200 to 1,500 meters. The flight paths of the aircraft are indicated by the east to west tracks on the map. The raid was countered in the forward area by a short-range air defense (SHORAD) system attrition zone and six PATRIOT fire units. The rear area defense consisted of 3 PATRIOT and 4 HAWK fire units and 12 Blue interceptor aircraft at the airbases and on combat air patrol (CAP). A forward ground sensor and orbiting Airborne Warning and Control System (AWACS)-type aircraft (hexagonal track) provided the air picture to a centrally located command and control center (COMC).

b. Test runs were conducted using only the ground high-to-medium altitude air defense (HIMAD) fire units to counter the threat, then those units were removed and replaced by Blue interceptor aircraft as the only defense.
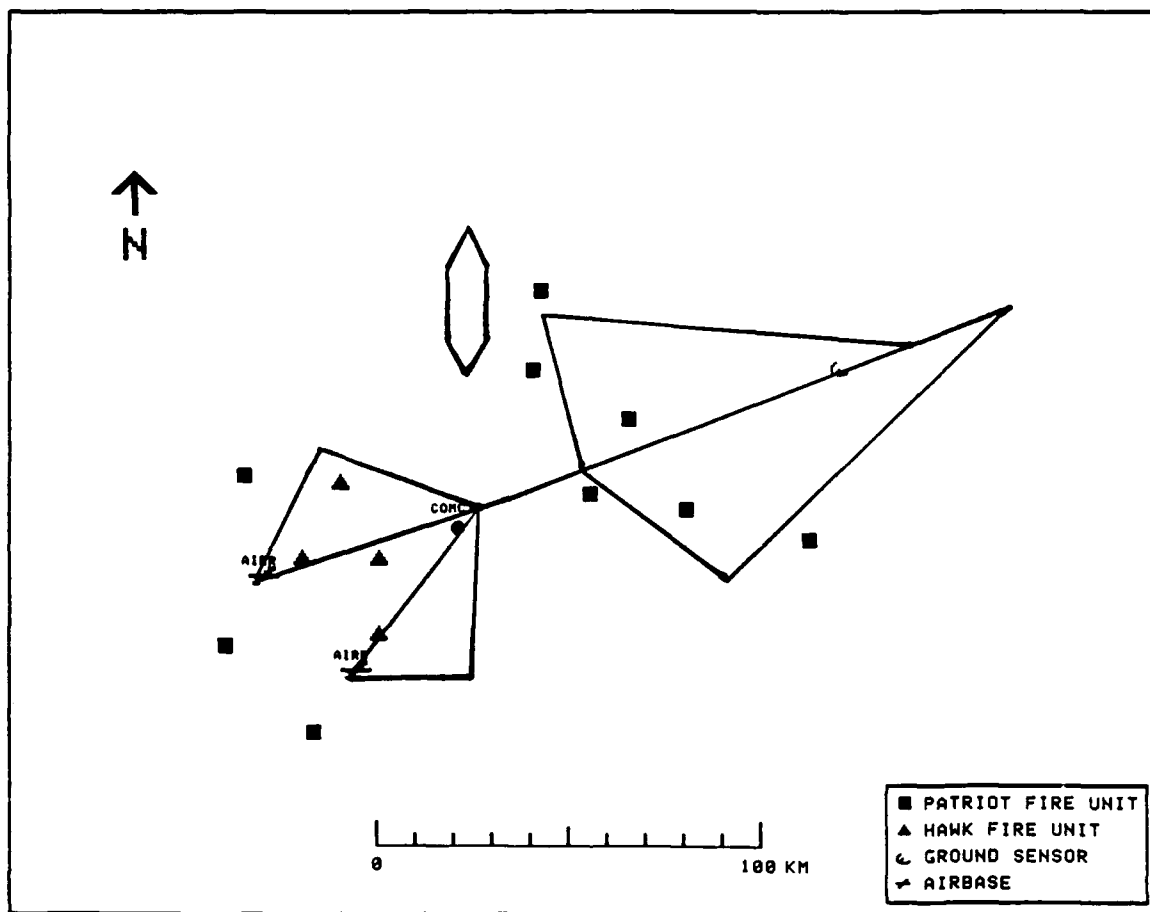
Figure 2-1. CIAD/CISCIAD Comparison Test Scenario

2-4. MEASURES OF EFFECTIVENESS (MOE). For the comparison test runs, it was important to review many MOEs to determine whether the models were functioning alike. Table 2-1 shows MOEs chosen for the surface-to-air and air-to-surface test runs using only a HIMAD defense. Table 2-2 lists the air-to-air MOEs for the runs when only the Blue interceptors were employed to counter the threat.

Table 2-1. Measures of Effectiveness (surface-to-air and
air-to-surface)

```
 1.  HIMAD and SENSOR detections
 2.  Targets dropped by HIMAD and SENSOR
 3.  Surface-to-air missiles aborted
 4.  Surface-to-air missile PK misses
 5.  Antiradiation missiles launched against HIMADs
 6.  HIMADs destroyed by antiradiation missiles
 7.  Forward HIMAD surface-to-air missiles launched
 8.  Forward HIMAD surface-to-air missile launch range (km)
 9.  Target aircraft killed by forward HIMAD
10.  Target aircraft kill range (km) by forward HIMAD
11.  Rear HIMAD surface-to-air missiles launched
12.  Rear HIMAD surface-to-air missile launch range (km)
13.  Target aircraft killed by rear HIMAD
14.  Target aircraft kill range (km) by rear HIMAD
```

Table 2-2. Measures of Effectiveness (air-to-air)

```
 1.  Interceptor aircraft dispatched from base and CAP
 2.  Interceptor aircraft ground control intercept update
 3.  Targets detected by Blue
 4.  Dogfights initiated
 5.  Aircraft killed in dogfights
 6.  Special maneuvers made
 7.  Interceptors switching targets
 8.  Air-to-air missile launches
 9.  Blue air-to-air missile launch range (km)
10.  Blue aircraft killed by air-to-air missiles
11.  Red aircraft killed by air-to-air missiles
12.  Range for Blue aircraft killed (km)
13.  Range for Red aircraft killed (km)
14.  Air-to-air missile aborts
15.  Air-to-air missile PK misses
```

2-5. TEST RESULTS

a. Surface-to-air and Air-to-surface Test

(1) This test included only the PATRIOT and HAWK fire units, ground
sensor, and AWACS-type aircraft as the air defense. Many different trials
were run using this scenario, and discrepancies were corrected in the CISCIAD
model code as needed. The final test results for the MOEs are shown in Table
2-3. The means and standard deviations for six replications using each model
are presented. The decision to use six replications was based on a previous
statistical analysis of replications required. This analysis was performed

on the CIAD Model as part of the CAA Air Defense Employment Options Study, CAA-SR-87-24, September 1987 (LTC James N. Carpenter (SECRET)). While, in general, more replications may be desirable, the expense in increased computer time was not justified for these preliminary test runs.

Table 2-3. Surface-to-air and Air-to-surface Scenario Test Results

Type	CIAD		CISCIAD	
	Mean	Standard deviation	Mean	Standard deviation
HIMAD and SENSOR detections	540.17	63.22	475.17	115.58
Targets dropped by HIMAD and SENSOR	481.33	56.04	415.33	102.96
Surface-to-air missiles aborted	17.50	2.95	12.00	10.94
Surface-to-air missile PK misses	71.33	9.65	71.83	14.47
Antiradiation missiles launched against HIMADs	7.67	.82	7.17	1.47
HIMADs destroyed by antiradiation missiles	5.00	.89	3.67	2.16
Forward HIMAD surface-to-air missiles launched	69.50	11.11	84.17	11.51
Forward HIMAD surface-to-air missile launch range (km)	36.00	.96	35.18	.70
Target aircraft killed by forward HIMAD	26.83	2.99	35.67	9.03
Target aircraft kill range (km) by forward HIMAD	31.75	1.68	30.00	.89
Rear HIMAD surface-to-air missiles launched	84.50	10.69	65.67	16.84
Rear HIMAD surface-to-air missile launch range (km)	26.82	.87	25.86	1.60
Target aircraft killed by rear HIMAD	38.33	5.01	30.33	5.85
Target aircraft kill range (km) by rear HIMAD	24.80	1.03	22.93	1.27

(2) The results indicate fairly good agreement between the two models in the preliminary tests of the air-to-surface and surface-to-air logic. Each of the pairs of MOEs generally overlap within one standard deviation. Although the total number of target aircraft killed is almost identical, the CIAD Model shows more kills by rear HIMADs than forward HIMADs, while the reverse is true for the CISCIAD Model. This discrepancy warrants further investigation in future tests of the model.

b. Air-to-air Test

(1) This test scenario consisted of Blue interceptors, the ground sensor, and AWACS-type aircraft countering the threat. The air-to-air engagement logic proved to be the most difficult area in which to obtain agreement between the two models. This appears to be the major area of modification to the CIAD Model by AFOTEC after the contractor began work on the CISCIAD Model in February 1986. The AFOTEC modifications to the CIAD Model between February and May 1986 were not incorporated by the contractor into the CISCIAD Model. During the course of the CISE Study, CAA made many updates and corrections to the CISCIAD Model air-to-air engagement logic in an effort to obtain better agreement between the models. These changes are addressed later in this chapter and in Appendix E.

(2) The air-to-air test scenario was modified to include only the 24 escort aircraft in the attacking raid to more closely observe the air-to-air engagements and attempt to isolate the source of the remaining discrepancies. The results of this test are displayed in Table 2-4. The means and standard deviations are shown for six replications of the CIAD Model run and only five replications for the CISCIAD Model run. The source of the error in the sixth replication was not discovered before the decision was made to end the study.

(3) The results indicate that many problems still exist in the air-to-air engagement logic. The CISCIAD Model counts of "special maneuvers made" and "interceptors switching targets" are excessive. The numbers of missiles launched, launch range, kills of Blue aircraft, and range for Blue aircraft killed are all lower in the CISCIAD Model.

Table 2-4. Air-to-air Scenario Test Results

Type	CIAD		CISCIAD	
	Mean	Standard deviation	Mean	Standard deviation
Interceptor aircraft dispatched from base and CAP	18.33	3.44	38.00	9.03
Interceptor aircraft ground control intercept update	212.17	3.31	448.00	59.23
Targets detected by Blue	9.33	3.78	57.00	6.04
Dogfights initiated	0	0	.80	.84
Aircraft killed in dogfights	0	0	1.00	1.22
Special maneuvers made	16.33	18.98	1060.20	319.61
Interceptors switching targets	8.17	8.66	241.00	42.69
Air-to-air missile launches	51.00	5.73	39.60	4.62
Blue air-to-air missile launch range (km)	13.92	2.89	7.11	1.22
Blue aircraft killed by air-to-air missiles	11.83	.41	.20	.45
Red aircraft killed by air-to-air missiles	4.83	3.43	13.40	2.70
Range for Blue aircraft killed (km)	14.03	.61	1.71	0
Range for Red aircraft killed (km)	6.74	2.64	4.54	.67
Air-to-air missile aborts	20.17	4.49	16.60	.55
Air-to-air missile PK misses	14.17	4.75	10.40	3.36

2-6. SUMMARY OF CISCIAD MODEL CHANGES. A summary of the CAA modifications to the CISCIAD Model during the course of the CISE Study is displayed in Table 2-5. It should be noted that many of these changes were based on AFOTEC modifications made to the CIAD Model that were not made to the CISCIAD Model. A detailed list of the actual modifications and the explanation for each change are contained in Appendix E.

Table 2-5. Summary of CISCIAD Model Changes

Model source code area	Number of changes
Interceptor/escort engagement logic	65
HIMAD logic	18
Missile launch/explode logic	15
Command and control center dispatch of interceptors	13
Miscellaneous	28

2-7. SUMMARY

a. A review of the comparison test results identifies many CISCIAD Model problem areas that need to be explored. The model requires further testing, primarily of the air-to-air engagement logic, to isolate the sources of the discrepancies. Also observed in the comparison was that many of the differences between the models were masked when running the complete scenario. It falsely appeared that the two models were producing similar results in many areas where problems existed. This emphasizes the need for testing weapon systems individually in the model.

b. The test scenario input files for both the CIAD and CISCIAD Models as well as the CAA version of the CIAD Model weapon decks have been provided on magnetic tape to TRAC-WSMR to assist in their debugging effort.

CHAPTER 3

FINDINGS

3-1. INTRODUCTION

a. The study comparison between the CIAD Model and CISCIAD Model produced several findings which are presented below.

b. The test scenario input files for both the CIAD and CISCIAD Models as well as the CAA version of the CIAD Model weapon decks have been provided to TRAC-WSMR to assist in their debugging effort

3-2. FINDINGS

a. The CISCIAD Model was successfully installed on CAA's VAX 8600 computer; however, the study only progressed to the first staqe of performinq the comparison tests using one weapon system at a time. The initial release (October 1987) contained errors in the contractor-added software. The contractor and TRAC-WSMR continued to fix these problems as well as make other improvements to the basic model after having released it to CAA. Since the model was in such a turbulent state, the CISE Study was put on hold in April 1988 until TRAC-WSMR could release a final version. All of the CAA corrections made to the CISCIAD Model between January 1988 and April 1988 were sent to TRAC-WSMR at that time. TRAC-WSMR released a final version of the model to CAA in July 1988.

b. Comparisons of test results between the CISCIAD and CIAD Models showed similarity in the air-to-surface and surface-to-air logic (without utilizing the new CISCIAD Model features); however, numerous discrepancies were revealed, mainly in the air-to-air portion of the models. This appears to be the major area of modification to the CIAD Model by AFOTEC after the contractor began work on the CISCIAD Model in February 1986. These AFOTEC modifications to the CIAD Model were not incorporatec by the contractor or TRAC-WSMR in the CISCIAD Model. The fact that the CISCIAD Model was developed from an earlier version of the CIAD Model than the one in use at CAA is the cause of most of the differences discovered.

c. Differences still exist between the two models, and at the time of this report, the decision was made to defer further consideration of the CISCIAD Model at CAA until a later date when the model has reached a better level of maturity.

3-3. SUMMARY

a. The comparison revealed that the basic surface-to-air and air-to-surface modules (without utilizing the new CISCIAD Model features) produce fairly similar results with both models. The study also highlighted areas where further testing is required. Problems in the air-to-air engagement logic are significant and need to be isolated and corrected before the model should be considered for use in analysis involving air-to-air combat.

b. The development of CISCIAD was a highly ambitious effort which added a large number of complex features to an already complex model. Common to software development efforts of this magnitude is the need for an extended test and debug period. The proponent is continuing efforts to refine CISCIAD, and the model should, at some time in the future, prove to be a powerful tool for supporting air defense analyses.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

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APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
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BETHESDA, MARYLAND 20814-2797

REPLY TO
ATTENTION OF

CSCA-FSC

0 9 DEC 1987

MEMORANDUM FOR ASSISTANT DIRECTOR, FORCE SYSTEMS DIRECTORATE

SUBJECT: Combat Identification Systems COMO IAD Model Evaluation (CISE) Study

1. PURPOSE OF DIRECTIVE. This directive establishes objectives and provides guidance for the conduct of the Combat Identification Systems COMO IAD Model Evaluation (CISE) Study.

2. BACKGROUND

 a. This effort began as part of the CAA Air Defense Models Modification (ADM2) Study (completed in September 1986). ADM2 involved assisting the US Army TRADOC Analysis Command (TRAC) in developing a statement of work and monitoring a contract to modify the COMO Integrated Air Defense (CIAD) Model (currently in use at CAA). The modifications were to include command, control and communications (C3), airspace management and identification friend or foe (IFF). The contract commenced in February 1986 by Veda Incorporated, and was subcontracted to SRS Technologies. TRAC accepted delivery of the model in June 1987.

 b. One of the objectives of the ADM2 Study was to provide CAA with an air defense model that could simulate C3, airspace management and IFF and to install the model at CAA when the modification contract was completed.

3. STUDY SPONSOR. Director, US Army Concepts Analysis Agency (CAA).

4. STUDY AGENCY. Force Systems Directorate, US Army Concepts Analysis Agency.

5. TERMS OF REFERENCE

 a. Purpose. Install, test and make operational on the VAX 8600 at CAA the TRAC Combat Identification Systems COMO Integrated Air Defense (CISCIAD) Model.

 b. Scope. The TRAC CISCIAD Model will be installed, modified and operated on the VAX 8600 computer at CAA.

 c. Objectives

  (1) Install the TRAC CISCIAD Model on CAA's VAX 8600 computer.

  (2) Implement the modifications made to the CIAD Model by CAA in the CISCIAD Model.

CSCA-FSC
SUBJECT: Combat Identification Systems COMO IAD Model Evaluation
(CISE) Study

   (3) Determine whether the output results of the CISCIAD and CIAD
Models are similar given the same scenario and conditions.

   (4) Test the new command, control and communications, airspace
management and IFF features of the CISCIAD Model for software bugs and
evaluate the results for reasonableness.

   d. Assumption. Since the CISCIAD Model has been accepted by TRAC,
the technical functioning of the modifications made by the contractor
have been verified and approved.

   e. Essential Elements of Analysis (EEA)

   (1) Can the CISCIAD Model be installed and operated on the CAA VAX
8600 computer and updated with CAA CIAD enhancements?

   (2) How do the results of the CIAD and CISCIAD Models compare using
the same scenario?

   (3) What are the capabilities of the CISCIAD Model to simulate C^3,
airspace management and IFF? What are the limitations?

   f. Responsibilities. FS will provide the study team, conduct the
study and perform the model installation and operation.

6. LITERATURE SEARCH

   a. A Defense Technical Information Center (DTIC) search has been
conducted.

   b. Related Studies

   (1) Air Defense Models Modification (ADM[2]) Study, CAA, September
1986.

   (2) COMO Integrated Air Defense (IAD) Model Evaluation (CME) Study,
December 1986.

7. ADMINISTRATION

   a. Support. Funds for travel and per diem will be provided by CAA.

CSCA-FSC
SUBJECT: Combat Identification Systems COMO IAD Model Evaluation
(CISE) Study

b. Milestone Schedule

     CiSCIAD Model installation completed   31 December 1987
     Comparison runs and analysis of results
     between CIAD and CISCIAD Models completed   29 February 1988
     Evaluation of CISCIAD Model results
     completed   15 April 1988
          Final report published   31 May 1988

c. Coordination. FSC is authorized direct coordination with TRAC in
the installation and testing of the CISCIAD Model.

E.B. VANDIVER III
Director

3

APPENDIX C

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APPENDIX D

COMO MODELING SYSTEM

D-1. INTRODUCTION. This appendix briefly describes the COMO Modeling system and provides a background and description of the CIAD Model.

D-2. COMO STRUCTURE

    a. COMO is a stochastic, critical-event-stepped, Monte Carlo combat simulation model developed by SHAPE Technical Centre (STC) in the 1960s. It was designed as a readily adaptable model to study tactical weapon systems. Figure D-1 illustrates the major components of the COMO structure.
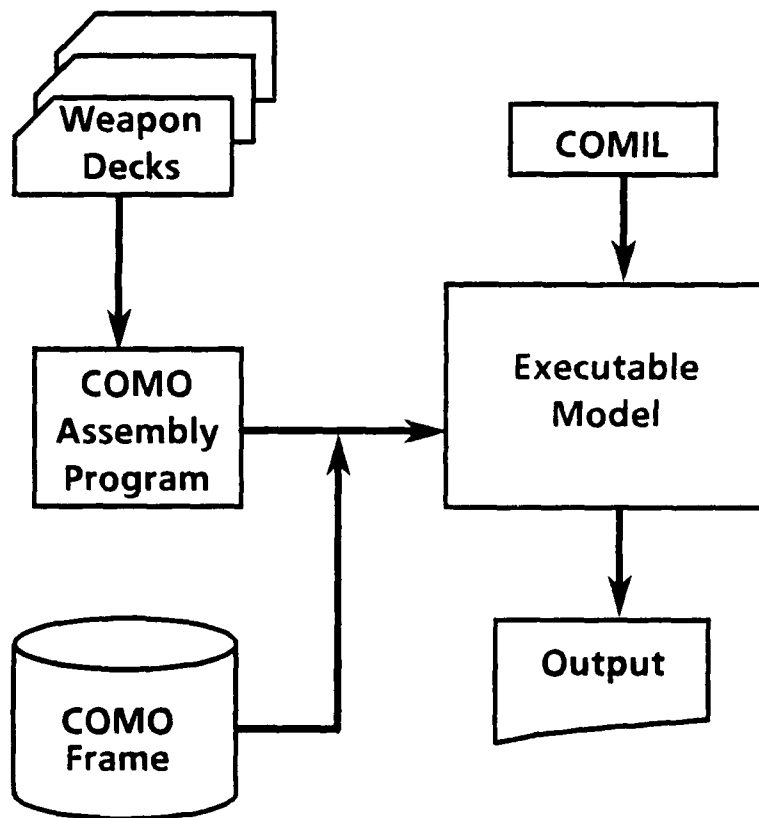
Figure D-1. COMO Structure

b. The **COMO Frame** is a collection of subroutines which reads and edits the input data, performs bookkeeping functions, and controls the execution of the simulation. The **weapon decks** are sets of subroutines and control statements describing the critical events which characterize the activity of weapon systems. Detecting an aircraft, launching a missile, and refueling are examples of these events. Since the weapon decks are a separate element of the COMO structure, different weapon decks can be integrated into the model. The user includes only those decks for the weapon systems that will participate in a particular scenario. Supporting software, required to prepare the weapon decks for merger with the COMO Frame, is called the **COMO Assembly Program.** The scenario is described using the **COMO Input Language** (COMIL) by specifying the numbers, locations and performance characteristics of the weapon systems. Examples of performance characteristics are aircraft speed, fuel consumption rate, missile launch delay time and probability of kill.

D-3. COMO INTEGRATED AIR DEFENSE (CIAD) MODEL

a. In 1981, STC developed the "COMO III Integrated Air Defense Model with Command and Control" (CIAD) through a contract with General Research Corporation (GRC). The US Air Force Operational Test and Evaluation Center (AFOTEC) acquired the CIAD Model from STC in 1983. Under a contract sponsored jointly by AFOTEC and Sandia National Laboratories, GRC converted the COMO Frame and COMO Assembly Program to the ANSI FORTRAN 77 standard, creating a machine-portable version of COMO. The model had previously been programed using FORTRAN IV and assembly language. During 1983-1985, AFOTEC programers modified and improved the CIAD weapon decks to be compatible with the new machine-portable COMO Frame. CAA obtained the CIAD Model from AFOTEC in October 1985.

b. The CIAD Model contains a complete set of weapon decks to simulate a theater-level ground-to-air, air-to-air, air-to-ground, and surface-to-surface missile battle. Table D-1 lists the types of weapon systems available in the CIAD Model.

Table D-1. CIAD Model Weapon Systems

```
┌─────────────────────────────────────────────────────────────────────┐
│ Defensive forces:                                                     │
│                                                                       │
│     High-to-medium-altitude Air Defense (HIMAD):  autonomous or       │
│     coordinated surface-to-air missile fire unit                      │
│                                                                       │
│     Interceptor (INCEPTB):  air-to-air combat                         │
│                                                                       │
│     Command and Control Center (COMCTR):  coordination of HIMADs and  │
│     interceptors                                                      │
│                                                                       │
│     Short-range Air Defense System (SHORAD):  attrition zone          │
│                                                                       │
│     Early Warning and Tracking Radar (SENSOR):  ground or airborne type│
│                                                                       │
│     AIRBASE:  interceptor base for strip alert, rearming, and refueling│
│                                                                       │
│ Offensive forces:                                                     │
│                                                                       │
│     Penetrator (BOGEY):  air defense suppression, escort, and bombing │
│     missions with or without self-screening ECM                       │
│                                                                       │
│     JAMMER:  escort and standoff ECM                                  │
│                                                                       │
│     Surface-to-surface missile                                        │
└─────────────────────────────────────────────────────────────────────┘
```

c. A representative scenario employing all of the CIAD Model weapon systems is illustrated in Figure D-2. Blue air assets consist of interceptors on combat air patrol (CAP) and in various readiness states at airbases. Command and control centers receive target information from remote or collocated sensors, orbiting Airborne Warning and Control System (AWACS)-type aircraft, and HIMADs. The command and control centers assign and guide interceptors toward target aircraft. HIMADs fire at targets they are tracking but are restricted by the command and control center from engaging those targets which are fully allocated to other HIMADs and interceptors. A region can be defined as a SHORAD attrition zone. All Red aircraft flying through this zone are subject to attrition depending on the density of sites, rate of fire, and kill probability. An interceptor defense line limits the flight of interceptors to protect against fratricide. Red attacking assets consist of orbiting standoff jammers (SOJ), escort jammers (ESJ), escort fighters, and bombers and air defense suppression aircraft with self-screening jam (SSJ) capability.
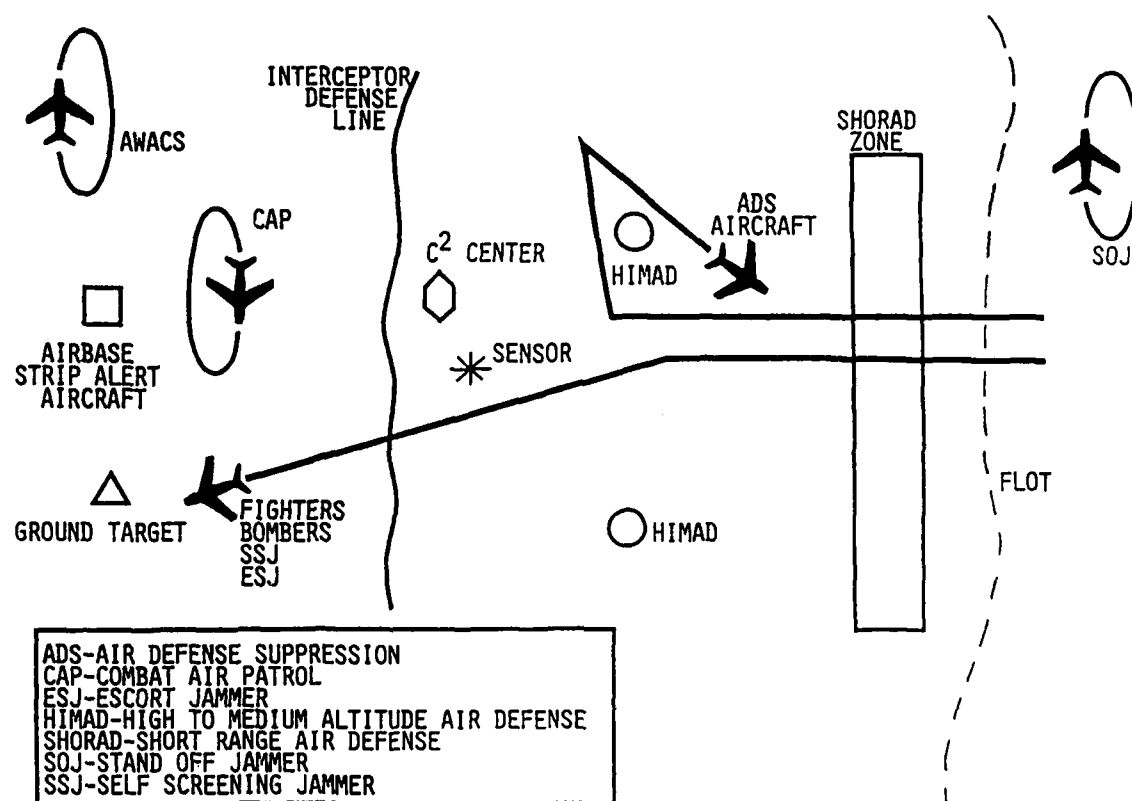
Figure D-2. CIAD Model Typical Scenario

APPENDIX E

CISCIAD MODEL CORRECTIONS AND UPDATES

The following list encompasses all changes made to the CISCIAD Model by CAA throughout the period from January 1988 to November 1988. The double dashed lines are used to separate each change (or related changes). The date of the change is indicated at the top right-hand corner of the section with an explanation for the correction at the bottom.

```
========================================================================
Subroutine BM2                                              1/12/88

        Declare:
            LOGICAL LONG,SDT
            INTEGER TRINC

        Move:
            CALL TRBIT(NP,ITR,JBIT)
        To: the line below the comment
            C *** MISSILE IS A SAM

            Below NTF=NBMTF(BM)
        Insert:
            SDT = .FALSE.

            Below label 45
        Insert:
            IF (P.EQ.SDTGT(NP)) SDT = .TRUE.

        Change:
            3 KM=MODEK(MT)
        To:
           41 KM=MODEK(MT)

            Before label 41
        Insert:
            3 IF (NTF.EQ.0 .OR. FNDF) GO TO 41
            IF (SDT) GO TO 41
            KOUT = TRINC(P,JBIT)
            KOUT = KOUT/ITR-2*(KOUT/(2*ITR))
            IF (KOUT.NE.0) GO TO 41
            RESIND(1) = 41
            GO TO 28

        The above changes create and set RESIND 41 which means that the
    HIMAD lost track on the target before the missile burst.  D. Michael
    had made this change to the CIAD version of the model CAA is currently
    using.
========================================================================
Subroutine BM2                                              1/12/88

            Before label 88
        Change:
            IF (.NOT.ESC(P) .AND. .NOT.FNDF) RESIND(2)=19
        To:
            IF (.NOT.ESC(P) .AND. LONG(MT)) RESIND(2)=19

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

- -

Subroutine BI4   1/12/88

          After label 10
     Insert:
          CALL ZLONG(ML,.TRUE.)

          After label 6
     Insert:
          CALL ZLONG(MS,.FALSE.)

          Between labels 6 and 7
     Change:
          DTS = DTSA(ML)
     To:
          DTS = DTSA(MS)

          On the next line
     Change:
          IF (NSLVO(ML) .GT.1) DTS=DTS/NFR
     To:
          IF (NSLVO(MS) .GT.1) DTS=DTS/NFR

          The changes between labels 6 and 7 were due to a mistake in the
     code. ML is the medium range missile and MS is the short range missile
     and this particular section of code is dealing only with short range
     missiles.

- -

CISCIAD.ORG file   1/12/88

          In the GENMIS weapon deck
     Add:
          $4 LONG   20   1   0   1

- -

          These changes were made by CAA because it   ssumed in the model
     that short range air-to-air missiles are fire an'   get and that
     medium range air-to-air missiles are not fire a..   net. That is no
     longer the case, so to get the RESINDs posted cor   , a flag had to
     be created in the GENMIS weapon deck to indicate ..   ther the missile
     is short or medium range.
==

```
===========================================================================
Subroutine SYSBO                                                   1/12/88

        Declare:
            INTEGER SA,SP
            REAL RCHK
            LOGICAL COMPAT
            EXTERNAL RVIS

                Before label 20
        Insert:
            SA = ACTCU(1)
            SP = PASCU(1)
            ACTCU(1) = P
            PASCU(1) = PAR1
            RCHK = R(P,PAR1)
            IF COMPAT(RCHK,RVIS)) GO TO 19
            ACTCU(1) = SA
            PASCU(1) = SP
            RETURN
         19 ACTCU(1) = SA
            PASCU(1) = SP
```

This change was make by CAA so that ARM launching BOGEYs would only be able to detect HIMADs that could detect them based on the terrain (RVIS) of the HIMAD. The ARM launchers were not subjected to terrain the way the HIMADs were, therefore, the BOGEY was set to the PASCU array and the HIMAD put into the ACTCU array. Then all that was needed was to compare the range to RVIS.

```
===========================================================================
Subroutine RS1                                                     1/12/88

        Declare:
            REAL N1MIS

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine GU1                                                     1/12/88

        Declare:
            REAL N1MIS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

        CAA had made this change is RS1 for the CIAD model earlier, but just recieved change for CISICAD model from F. Burns, SRS.
```
===========================================================================
```

```
================================================================================
Subroutine USRCOM                                               1/20/88

        Add:
            COMMON /BOG/ NBOG1

        Insert:
            C  -  BO1  -
                NBOG1 = 0

        Subroutine BO1 looks for a previous value in common variable NBOG1.
    When running more than one replication, an old combat unit number is
    left in NBOG1, which causes the model to crash when this number happens
    to be larger than LCU.  The solution is to reset NBOG1 between
    replications.
================================================================================
Subroutine RS1                                                  1/21/88

            At the beginning, after N=1
        Insert:
                DO 222 L = 1,10
            222 NPASCU(L) = 0


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -


Subroutine RS2                                                  1/21/88

        Delete:
            DIMENSION NPASCU(10)

            At the beginning, after RS=ACTCU(1)
        Insert:
                DO 222 L = 1,10
            222 NPASCU(L) = 0


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutines / Functions   RS2,IDEXEC,PDECLR,IDXCMD,QUERY,XPONDS   1/21/88

        Add:
            COMMON /NPASC/ NPASCU(10)

            After each occurence of setting the RESIND array
        Insert:
            IF (K.LE.10) NPASCU(K) = P
                    or
            IF (IR.LE.10) NPASCU(IR) = P

        (use K or IR, whichever one applies)


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

- -

Subroutine PDECLR 1/21/88

       Before label 1000
   Insert:
     IF (IR.GT.10) IR = 10

- -

    These changes were made because the PASCU array was not getting
set properly to post RESINDs to the summary file through SPEC1.
===

Subroutine RS2 1/21/88

    Where RESIND 30 is posted, we deleted the K=K+1 statement and the
posting of the RESIND array. We left the call to EVNOUT. RESIND 30
corresponds to link failures. These were happening so frequently when
COMIL variable PXMIT=80 was used, that the 10 positions in the RESIND
array were getting filled and we were never able to see what other
RESINDS were set. RESIND 30 still gets posted to the TAPE15 file to
monitor the number of link failures, but it will not get counted in
the summary statistics.
===

Subroutine USRCOM 2/8/88

   Move:
     C *** DTO ***
       KOUNT=0
       CTR=0
       K=0
       ISWW=0
       NFLG=1
       LDR=0
       WRITE(8,200) NREPS
       WRITE(16,200) NREPS
To: the bottom of the routine, before the 200 FORMAT statement

    The variable K is in a common block and gets used as the number
of SHORAD units in the game. In USRCOM, K was initialized to 0, but
then reused as a DO LOOP controlling variable and a value of K=7 was
left.
===

==

Subroutine BM2   2/9/88

        Just above label 2500, before IF (CRMSL(NP).OR.TYPSS(NP)) etc.
Insert:
        IF (ITG.NE.'   BOGEY') GO TO 301

        2 lines below
Change:
         XPO=XP*.001
To:
        301 XPO=XP*.001

        Several lines below
Delete:
        IF (CRMSL(NP).OR.TYPSS(NP)) CALL REMVCU(NP)

    This was necessary because CRMSL and TYPSS should not be accessed
by anything other than a BOGEY unit. The deletion is because the
statement is a repeat of the one above label 2500.
==

Subroutine LAUNCH   2/11/88

        Declare:
        CHARACTER*8 TGNAME,ITG

        Before the statement, IF (TYPSS(AC).OR.CRMSL(AC)) GO TO 5
Insert:
        ITG = TGNAME(CLASS(AC))

        On the next line
Change:
        IF (TYPSS(AC).OR.CRMSL(AC)) GO TO 5

        IF (ITG.EQ.'   BOGEY'.AND. (TYPSS(AC).OR.CRMSL(AC))) GO TO 5

    TYPSS and CRMSL variables should not be accessed if AC is not a
BOGEY unit.
==

CISCIAD.ORG file   2/12/88

        In the FIBOMBR weapon deck
Add:
        $3 SCRUS

    The BI3 event is executed for escorts when in pursuit of a target.
It accesses the SCRUS(FI) in several places. After talking to Fennell
Burns, he said the change should be made to BI3 to access the FLTSPD
of the BOGEY rather than SCRUS if the unit is an escort. He said that
SCRUS should not really be added to the FIBOMBR weapon deck.
==

```
=========================================================================

Subroutine RS1                                                   2/16/88

          Below label 22
     Move:
          TR = TREDY(RS)
     To:  directly below the statement TSAVE = T

          Change from TRAC-WSMR.
=========================================================================

Subroutine LAUNCH                                                2/18/88

          About 17 lines below label 2,
          following the statement, IF (ITG.EQ.'   BOGEY .AND.(TYPSS etc.
     Insert:
          IF (FI.EQ.-1 .OR. FI.EQ.0) GO TO 4

          This is a very important change.  HIMAD launches were getting
     scheduled for the intercept time rather than the launch time.
=========================================================================

Subroutine RS2                                                   2/22/88

          A few lines below label 87
     Change:
          IF (TR.GT.TR+DT2) GO TO 100
     To:
          IF (TR.GT.TR+DT3R) GO TO 100

          This change was made in the CAA CIAD model.  DT3R is the time
     between decision to launch and actual missile away, therefore, the
     check should be made to see if the launcher will be ready by that
     time rather than the RS2 cycle time.

     Change:
          921 TR = TR + DT4R
     To:
          921 TR = TR + DT4R*NSS

          NSS is the number of missiles salvoed and DT4R is the time
     between missile launches.  DT4R should be multiplied by the SALVO
     to calculate the next launcher ready time.  This change was made to
     CIAD by D. Michael, AFOTEC.
=========================================================================

Subroutine RS2                                                   2/22/88

          Above label 930, before CALL SILENC(RS,T)
     Insert:
          IF (MSMISR.NE.0) THEN
             CALL ZOUTAC(RS,.TRUE.)
             GO TO 930
          ENDIF
```

- -

- -

Subroutine BM2   2/22/88

        Declare:
            LOGICAL OUTAC

            After label 28
        Insert:
            IF (ITG.EQ.'   HIMAD' .AND. MSMIS(NP).EQ.0 .AND. OUTAC(NP)) THEN
            CALL SILENC(NP,T)
            IF (MSHT(NP).GT.0) CALL ZOUTAC(NP,.FALSE.)
            ENDIF

- -
        HIMAD radars were being turned off (when out of missiles and the
reload time required the radar to be turned off) in the same RS2 event
as the last missile was scheduled to be launched. Subroutine SILENC
drops track on all targets for that HIMAD, therefore, the radar was not
staying up long enough to let the missiles reach the intercept point.
This change was made to CIAD by D. Michael, AFOTEC. This puts the
HIMAD out of action without dropping track on targets until the last
missile has exploded (MSMIS=0) and then calls SILENC.
==

Subroutine ADDFIL   3/1/88

            Following the code which assigns the COMCTR grid coordinates
            to the trackfile, after CALL ZTGT(TF,GL)
        Insert:
            CALL ZENGD(TF,.FALSE.)

            To initialize the ENGD flag for the trackfile.
==

Subroutine KINCHK   3/17/88

            At label 4
        Change:
            C - INTERCEPTOR IS AUTONOMOUS AVOID CROSSING STOPLINE
                IF (FROM.EQ.2.OR.FROM.EQ.3) CALL TESTLN(CO,XI,YI,EXT)
        To:
            C - AVOID CROSSING STOPLINE
                CALL TESTLN(CO,XI,YI,EXT)

            When checking base aircraft for intercept (FROM=1), TESTLN
        was not getting called.
==

Subroutine CO3   3/18/88

            Between labels 90 and 100
        Change:
            IF (N.GT.1) CALL ZEVIND(CO,1,1)
        To:
            IF (TCTIC(CO).NE.0 .AND. N.GT.1) CALL ZEVIND(CO,1,1)

            A change made by D. Michael, AFOTEC.
==

==

Subroutine BI3   3/22/88

        A few lines after line 1517, after ND=NFR-NFRN
    Insert:
        C ** IF THE INTERCEPTOR FORMATION DOES NOT SPLIT, RESET ND TO NFR
            IF (NFR.EQ.NFRN) ND=NFR

        When an interceptor formation switched to a new target, and the
    formation did not split, ALOCC was not getting deducted by the number
    in the formation (NFR-NFRN)=0 therefore, zero was getting deducted.
==

Subroutine CO3   3/23/88

        At label 12, change and insert the following
    Change:
        12 IF (DEAD(NF)) GO TO 30
           IF (DEAD(P)) GO TO 30
    To:
        12 PASCU(1) = TGT(NF)
           P = PASCU(1)
           IF (DEAD(NF)) GO TO 30
           IF (DEAD(P)) GO TO 30

        A few lines below
    Delete:
        PASCU(1) = TGT(NF)
        P = PASCU(1)

        The COMCTR was continuing to dispatch aircraft against a dead
    formation of BOGEYs because it was only looking at the DEAD flag of
    the trackfile rather than the flag of the PASCU.
==

Subroutine AB1   3/24/88

        After label 16, just before CALL CIRCLE
    Insert:
        CALL ZTLTGS(LDR,T)

        When a trackfile is dead, after interceptors are committed, but
    before they have left the AIRBASE, BIS deducts too much fuel because
    TLTGS (time last fuel decrement) was never set to anything but zero.
==

==

Subroutine AB2   3/24/88

       After label 10 CONTINUE, the code should read as:

```
        DM = DGVAL(AB)
        IF (DM.GT.CRDMG(AB)) THEN
           DT = DT/DM
           IF (EVTIND(FI,NAB3).NE.0) THEN
              CALL REPLAC(FI,NAB3,T+DT)
           ELSE
              CALL SCHEDL(FI,NAB3,T+DT)
           ENDIF
           CALL ZEVIND(FI,1,1)
           CALL BSORT(FI)
        ELSE
           IF (EVTIND(FI,NAB3).NE.0) GO TO 5
           CALL SCHEDL(FI,NAB3,T+DT)
           CALL ZEVIND(FI,1,1)
           CALL BSORT(FI)
        ENDIF
      5 RETURN
```

     This change was made because FIGHTERs were not getting rearmed
and refueled at the required time intervals (TGO2). Subroutine AB2
was rescheduling the AB3 event (REARM/REFUEL) at DT seconds after
each FIGHTER landed, therefore pushing back the event each time.
The AB3 event is executed for the FIGHTER weapon as a whole and not
for each aircraft that lands.

==

Subroutine TRCKWT   3/28/88

       Below label 8
Delete:
```
        IF (SLP.NE.SA) GO TO 81
        IF (SA.EQ.0) DELY = CA - YP
        GO TO 83
```

       At label 83
Delete:
```
     83 IF (SA.NE.0) GO TO 9
        DIST = -DELY * .001
        GO TO 11
```

- -

- -

Subroutine TRCKWT   Continued   3/28/88

          Just above label 11
     Change:
          DIST = TESTP * DIV * .001
     To:
          DIST = .5 * DELT

     Replace: label 11 with
          IWT = 700 - DIST
     Delete:
          81 IF (DELT.GT.0) GO TO 20

          2 Lines down
     Delete:
          9 DIV = 1./SA
          IF (CA.NE.0) DIV = DIV * SIGN(1.,CA)

     Targets outside of the defense line and incoming were getting a
higher priority than targets inside the defense line and incoming.
===

Subroutine BO2   3/28/88

          Near beginning
     Change:
          XT = T/DTR
     To:
          XT = T - INT(T/DTR) * DTR

     Delete:
          MT = XT

     Change:
          IF ((XT-MT).LT.DTB) PAR2 = 1
     To:
          IF (XT.LT.DTB) PAR2 = 1

     Escorts were not making visual searches because the calculation
was incorrect.
===

```
===================================================================================

Subroutine RS1                                                          3/28/88

            Below the statement 26 T = TSAVE
        Insert:
            TR = T + DT3(RS)

            A few lines below
        Delete:
            IF (TI.LT.T) TI = T + DT3(RS)

            Below label 270
        Change:
            TSHOOT = T + DT4(RS) * NF
        To:
            TSHOOT = TR + DT4(RS) * NF

            TREDY time should be T + DT4(RS).
===================================================================================

Subroutine B00                                                          3/28/88

        Change:
            CALL SCHEDL(A,B01,T+.001)
        To:
            CALL SCHEDL(A,B01,T+.0001)

        BOGEYs were entering the game and then getting detected before
        a B01 event got scheduled to "kill off" members of the formation so
        only the leader remains.
===================================================================================

Subroutine RS1                                                          3/29/88

            Between labels 24 and 26, after IF (RLTR) T=TI
        Insert:
            IF (H(P).LT.0) GO TO 28

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine RS2                                                          3/29/88

            After label 924 T = TI
        Insert:
            IF (H(P).LT.0) GO TO 100

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        These checks for the height of the passive unit are for TBM's to
        insure that the TBM's are not launched against if they are underground
        at intercept time.
===================================================================================
```

```
=======================================================================
```
CISCIAD.ORG file   3/29/88

        All places where DSTAT is accessed, the ACTCU(1) position must be
the unit which appears in the DSTAT() statement. For example DSTAT(CO)
does not check DSTAT for the CO unit but rather for the unit that is in
ACTCU(1) at the time of the call. In all cases where the unit being
tested is not in ACTCU(1), save the ACTCU(1), place the correct unit
into ACTCU(1), and then reset the ACTCU(1) back to the saved value
after the call to DSTAT.
```
=======================================================================
```
COMO4.DKS file   4/4/88

    In *DECK COMOZ, increase NEGNAG data initialization from 10 to 40.

        This is a count limit for NEGNAG for all replications. 10 is
too restrictive for six replications.
```
=======================================================================
```
Subroutine CORDN8   4/18/88

            Below label 20
        Change:
            FCRT = GASSO(FI) * .6
        To:
            FCRT = GASSO(FI) * .2

        Changed by D. Michael, AFOTEC, in the CIAD model. This sends
interceptors back to CAP if they have more than 20% of their fuel,
rather than circle in place.
```
=======================================================================
```
Subroutine RS2   4/18/88

            A few lines above label 95
        Change:
            CALL SILENC(RS,T)
        To:
            IF (MSMISR.EQ.O) CALL SILENC(RS,T)

        When there are no reloads available and HIMAD has missiles in
flight, SILENC should not be called until last BM2 event.

            Below label 93 NRLD = NRELD(RS)
        Insert:
            CALL ZMSMIS(RS,MSMISR)

        When out of missiles and reloading, MSMIS never gets set for
missiles launched before running out.
```
=======================================================================
```

==

Subroutine SPEC1   4/18/88

      The RESINDs were updated. There were 20 new ones added and 1
deleted for a total of 139 RESINDS.

Change:
    TMPLOC(110),TMP1(110),TMP2(110)
To:
    TMPLOC(139),TMP1(139),TMP2(139)

Change:
    DO 100 JJ = 1,110
To:
    DO 100 JJ = 1,139

      Change current TMPLOC, TMP1, and TMP2 to the following:

```
DATA TMPLOC /
+ 'AB1','AB1','AB1','AB2','AB2','AB2','AB3','AB3','AB3','AB3',
+ 'AB3','BI2','BI3','BI3','BI3','BI3','BI3','BI3','BI3','BI3',
+ 'BI3','BI3','BI3','BI3','BI3','BI4','BI4','BI4','BI4','BI5',
+ 'BI5','BI5','BI5','BI5','BI5','BI5','BM2','BM2','BM2','BM2',
+ 'BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2',
+ 'BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2',
+ 'BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2',
+ 'BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2','BM2',
+ 'BM2','BO1','BO1','BO1','BO1','BO1','BO1','BO1','BO1','BO1',
+ 'BO1','BO1','BO2','BO2','BO5','BO5','BO5','CO2','CO2','CO3',
+ 'CO3','CO3','CO4','CO4','CO4','CO4','FI1','FI1','FI1','GU1',
+ 'GU1','GU1','GU1','GU1','GU1','GU1','GU1','GU2','GU2','GU4',
+ 'GU4','GU4','GU4','GU4','GU4','GU4','HI3','RS1','RS1','RS1',
+ 'RS1','RS1','RS2','RS2','RS2','RS2','RS2','RS2','RS2'/
```

- -

- . - - - - - - - - - - - - - -

Subroutine SPEC1   Continued   4/18/88

```
        DATA TMP1 /
    +      1,     2,     3,     1,     2,     5,     1,     2,     3,     4,
    +      5,     1,     1,     2,     3,     4,     5,     6,     7,     8,
    +      9,    10,    11,    12,    13,     1,     2,     5,     6,     1,
    +      2,     3,     4,     6,     7,    11,     1,     2,     3,     4,
    +      5,     6,     7,     8,     9,    10,    11,    12,    13,    14,
    +     15,    16,    17,    18,    19,    20,    21,    22,    23,    24,
    +     25,    26,    27,    28,    29,    30,    31,    32,    33,    34,
    +     35,    36,    37,    38,    39,    40,    41,    42,    43,    44,
    +     45,     1,     2,    22,    23,    24,    25,    26,    27,    31,
    +     33,    35,     1,     2,     1,     2,     3,     1,     2,     1,
    +      2,     3,     1,     3,     4,     5,     1,     2,     3,     1,
    +      2,     3,     4,     5,     6,     7,     8,     1,     2,     1,
    +      2,     3,     4,     5,     6,     7,     1,     1,     2,     3,
    +      4,     5,     1,     2,     3,     4,     5,     6,     7/

        DATA TMP2 /
    +     12,    12,    12,    12,    12,    12,    11,    11,    11,    11,
    +     11,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,     5,     5,     5,     5,     5,     5,     5,     5,     5,
    +      5,    10,    10,    10,    10,    10,    10,    10,    10,    10,
    +     10,    10,     5,     5,    10,    10,    10,    14,    14,     8,
    +      8,     8,     5,     5,     5,     5,    11,    11,    11,     9,
    +      9,     9,     9,     9,     9,     9,     9,     9,     9,     9,
    +      9,     9,     9,     9,     9,     9,    10,     6,     6,     6,
    +      6,     6,     6,     6,     6,     6,     6,     6,     6/
```

===

Function AZIMR   4/20/88

        Just before RETURN
    Insert:
        IF (AZIMR.LT.-PI) AZIMR = AZIMR + PI2

        This is a critical correction. AZIMR was not returning the
    correct value when the target was on the positive side of the PTL,
    when the PTL was between +135 and +180 or between -135 and -180.

===

```
============================================================================
Subroutine BI3                                                      8/1/88

        A few lines above label 8899
    Change:
        IF (NFR.EQ.NFRN) ND=NFR
    To:
        IF (NFR.EQ.NFRN) THEN
          ND=NFR
          CALL ZINTTF(A,0)
        ENDIF

        Just above label 8899
    Delete:
        IF (ISW.EQ.1) CALL ZINTTF(A,0)

    Formation A should still be allocated to the old track file
    unless the formation did not split (when NFR=NFRN).
============================================================================

Subroutine USRCOM                                                   8/1/88

    Add:
        COMMON /BOG/ NBOG1

        C - BO1 -
          NBOG1 = 0

    Changed due to error in BO1.  Call was being made from BO1 with
    incorrect CU because NBOG1 was not initialized before second
    replication.  Value in NBOG1 was left over from first replication.
============================================================================

Subroutine RS1                                                      8/1/88

        At the beginning, after RS=ACTCU(1)
    Insert:
        DO 222 L=1,10
    222 NPASCU(L) = 0


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine RS2                                                      8/1/88

        At the beginning, after N=1
    Insert:
        DO 222 L=1,10
    222 NPASCU(L) = 0


- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        Changed due to error in RS2.  NPASCU array was not being
    initialized at the beginning of RS1 and RS2.  At the end of RS2,
    NPASCU is written into PASCU.
============================================================================
```

==

Subroutine PDECLR   8/1/88

          Before label 1000
     Insert:
        IF(IR.GT.10) IR=10

     This is the same as K getting incremented in RS2. When K.GT.10,
     K is always set = 10, but this is not done for IR which is passed
     back as K to IDEXEC and RS2.
==

Subroutine BM2   8/1/88

          After label 2500
     Delete:
        IF(CRMSL(NP).OR.TYPSS(NP)) CALL REMCU(NP)

     This statement applies to BOGEY, it was a repeat of the
     statement a few lines above it.
==

Subroutine RS1   8/1/88

          Below label 22
     Move:
        TR=TREDY(RS)
     To: up just after
        TSAVE=T

     Correction from TRAC-WSMR
==

Subroutine RS2   8/1/88

          Before label 930, before CALL SILENC(RS,T)
     Insert:
        IF (MSMISR.NE.0) THEN
          CALL ZOUTAC(RS,.TRUE.)
          GO TO 930
        ENDIF

     If the HIMAD is out of missiles on the launchers, but still
     guiding missiles in the air, do not silence the radar. Set the out of
     action flag. The radar will be silenced after all missiles explode in
     Subroutine BM2.
==

Subroutine BI3   8/1/88

          Before call to VISID
     Insert:
        HSTL = .FALSE.

     At the suggestion of F. Burns
==

===

Subroutine GU1   8/1/88

        Declare:
            REAL N1MIS

        At the suggestion of F. Burns

===

Subroutine CORDN8   8/1/88

            At label 1
        Change: the last
            F7.2
        To:
            F8.2

        TR can be as large as 60,000 - Default value put in the program.
    Caused an error in WRITE to summary file.

===

Subroutine CO3   8/29/88

            15 lines below label 50
        Insert: before RESIND(1)=2
            NR=NR+1
            IF(NR.GT.10) NR=10

        Change:
            RESIND(1)=2
        To:
            RESIND(NR)=2

        When allocating fighters to the intercept of BOGEYs, the
    result indicator was only getting set once for each engageable TF,
    but if one formation of strip ready fighters are not enough then
    another must be allocated to the TF and it must be represented in
    the result indicators.

            Down a couple more lines, after CALL EVNOUT(NCO3,2)
        Insert:
            NPASCU(NR)=P
            NACTCU(NR)=GL
            LKCU=0

- -
        Need to keep track of all different formations allocated to
    separate track files to coincide with RESIND array. Also LKCU
    must be set back to 0 so that NT=LKCU on the line below will be
    set back to 0 before the call to SCHLNK. This will ensure that
    SCHLNK will look for the proper link type instead of assuming the
    value which was left in NT from the last call to SCHLNK.

===

```
===============================================================================
Subroutine SILENC                                                     8/29/88

              After NCO=COMC(A)
         Insert:
              IF (NCO.EQ.0) RETURN

              When HIMAD is autonomous (COMCTR=NONE), SILENC was calling
         DRPTR to dump the tracks associated with the COMCTR, when the
         COMCTR=0.  This was causing an error.
===============================================================================
Functions POLCHK and POLICD          in COMO4.DKS                     8/29/88

              Under reject criteria
         Delete:
              IF ((IDUDZ.LT.1).OR.(IDUDZ.GT.27)) STOP 'POLCX01'

              Can not see any reason for checking the range.  This array holds
         the select and accept units and was limiting the number of units to 27
         for no apparent reason.
===============================================================================
Subroutine CO3                                                        8/31/88

         Add:
              COMMON /NARRAY/ NACTCU(10),NPASCU(10),NR
         Delete:
              DIMENSION NACTCU(10)
              DIMENSION NPASCU(10)

              Needed to define this common block so that the model would keep
         track of multiple CAP formations being sent out on GCI in routine
         CAPCHK.  Before only one position in the RESIND array was getting set.
===============================================================================
Subroutine CAPCHK                                                     8/31/88

              4 lines below label 20
         Insert:
              NR=NR+1
              IF (NR.GT.10) NR=10

              Next line down
         Change:
              RESIND(1)=1
         To:
              RESIND(NR)=1
         Insert:   directly after
              NACTCU(NR)=BI
              NPASCU(NR)=P

              These changes go with the 8/31/88 changes to CO3
===============================================================================
```

```
================================================================================

Subroutine BI3                                                         8/31/88

            8 lines below label 9010
        Change:
            IF (.NOT.SWE .OR. (MM1.EQ.0)) GO TO 13
        To:
            IF (SWE .AND. (MM1.NE.0)) GO TO 13

            This is the statement which tests and prevents the fighter from
        performing a special maneuver.  It was performing special maneuvers
        under conditions exactly opposite of those conditions for which the
        maneuver should be made.
================================================================================

Subroutine DT1                                                         9/12/88

        Add:
            COMMON /TIMER/ ITIMER_ADDR
        Declare:
            CHARACTER*20 CTIME,CDATE
            INTEGER*4 STATUS
            EXTERNAL LIB$SHOW_TIMER

                After declarations
        Insert:
            DATA CTIME,CDATE/2* '---N/A---'/

                At the very beginning
        Insert:
            IF (AMOD(T,200.).EQ.0) THEN
                CALL DATE(CDATE)
                CALL TIME(CTIME)
                PRINT *,'==========================================='
                PRINT *,' DATE: ',CDATE,'TIME: ',CTIME
                PRINT *,'      SIMULATION TIME = ',T
                STATUS = LIB$SHOW_TIMER(ITIMER_ADDR,1)
                STATUS = LIB$SHOW_TIMER(ITIMER_ADDR,2)
                PRINT *,'==========================================='
            ENDIF
            IF (SSNUMB.GT.1) THEN
                TD=ACTCU(1)
                TPR=DELT(TD)
                IF(T+TPR.LE.TSUCD(TD).OR.TSUCD(TD).LE.0)
          *         CALL SCHEDL(TD,NDT1,T+TPR)
                RETURN
            ENDIF

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

- -

Subroutine DT1   Continued   9/12/88

    All of this is to print out information to the SYS$OUTPUT file.
CPU, Elapsed, Simulation, and Real times as well as the date are
dumped out. This is to help with debugging the model and locating
where in a subsample the program is. It helps to locate when the
model is stuck in an infinite loop.

===

Subroutine USRCOM   9/12/88

    Add:
        COMMON /TIMER/ ITIMER_ADDR
    Declare:
        INTEGER*4 STATUS
        EXTERNAL LIB$INIT_TIMER

        At the beginning
    Insert:
        C *** INITIALIZE THE TIMER
        ITIMER_ADDR=0
        STATUS=LIB$INIT_TIMER(ITIMER_ADDR)

    This change goes with the 9/12/88 change to DT1. It just simply
resets the timer to 0 at the beginning of each subsample.

===

Subroutine CAPCHK   9/15/88

        Last line
    Change:
        IF (JF.EQ.0 .AND. BI.NE.0) CALL ZTINT(TF,TM)
    To:
        IF (JF.EQ.0 .AND. BI.NE.0 .AND. TM.LT.TINT(TF))) CALL ZTINT(TF,TM)

    This was changed to help with the discrepancy over the dispatching
of CAP aircraft between the CIAD and CISCIAD models. Change to CIAD
model from D. Michael, AFOTEC, 1986.

===

```
===================================================================================

Subroutine BOS                                                          9/27/88

        Add:
            *CALL PARAM
        Declare:
            INTEGER PAR3,PAR4,PAR5
            LOGICAL OUTGM,INDET

                5 lines below label 20, after IF(.NOT.COMPAT etc.
        Insert:
            IF (OUTGM(PASCU(1)).OR.INDET(PASCU(1))) GO TO 30
            PASCU(2)=NSHORD(INDVAL)

                A few more lines down, after IF(MSH.LE.0) GO TO 30
        Insert:
            PAR3=IG
            PAR4=JG
            PAR5=MSH-1

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine SPEC1                                                        9/27/88

        Declare:
            INTEGER PAR3,PAR4,PAR5

            In DATA TMP2 statement change the "go to" prompts from 10 to 16
        for the three BOS result indicators.

                Just above label 2
        Add:
            label 216 to the list of GO TO's


        Change: label 216
        To:     label 217


                Directly above label 212
        Insert:
            216  A=PASCU(2)
                 PASCU(1)=ACTCU(1)
                 KMIS=PAR3
                 KREL=PAR4
                 HA=PAR5
                 XA=0.
                 YA=0.
                 GO TO 300

 60             3 lines below label 212
        Change:
            GO TO 216
        To:
            GO TO 217

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

- -

Subroutine SPEC1 and BO5   Continued   9/27'88

      Changes were made to correct the posting of result indicators for
SHORAD. Also BO5 change checks to make sure BOGEY is not out of game
or in close combat (dogfight) before shooting.
==

Subroutine RS1   9/29/88

      Above label 11, change the IF - ENDIF block
Change:
    GO TO 11
To:
    GO TO 111

Delete:
    ELSE

Move:
    ENDIF up to where the ELSE was

Just below label 11, put a 111 label on statement CALL ZRED(RS,.TRUE.)

      This change was made because SDTGT was being accessed for SENSOR,
but SENSOR does not have a SDTGT.
==

Subroutine SPEC1   9/29/88

Declare:
    LOGICAL SAMF

      Directly below line 206 A=ACTCU(1)
Insert:
    IF (.NOT.SAMF(A)) GO TO 301

      This change was made because missile parameters were being
accessed by SENSOR which the SENSOR does not have.
==

```
=============================================================================

Subroutine CO3                                                    9/29/8

              .     1 line up form label 100
         Change:
              GO TO 195
         To:
              GO TO 191

                    2 lines below label 190
         Change:
                  DO 777 NR=2,10
         To.
              191 DO 777 NR=1,10

         Move: the line below label 190
              ACTCU(1)=CO
         To:    directly below label 777

              To correct the posting of result indicators in CO3.
=============================================================================

Subroutine INTIN                                                  9/29/8

         Move:
              CALL ZCLASS(I,JJ)
         To:   below label 12, beneath CALL ZZQ(I,II)

         Move:
              CALL ZINDET(I,.FALSE.)
         To:   below CALL ZCLASS(I,JJ), 4 lines down from label 12

              Need to have CLASS set before setting INDET of the interceptor.
=============================================================================

Subroutine BM2                                                    9/29/8

                    After label 28, below CALL RCUBM2(BM)
         Insert:
              ITG=TGNAME(CLASS(NP))
              IF (ITG.EQ.'   HIMAD') THEN

                    Then below the ENDIF from the IF(MSMIS(NP)) block
         Insert: another
              ENDIF

              Code in the IF - ENDIF block only applies to HIMAD.
=============================================================================
```

```
========================================================================

Subroutine SPEC1                                              9/29/88

     Change:
          208 A=ACTCU(L)
     To:
          208 A=ACTCU(1)

     Delete: from label 208 block
          KMIS=MMIS1(A)
          KREL=MMIS2(A)

     CO3 event posts ACTCU(1)=COMCTR and so SPEC1 was incorrectly
     extracting data.
========================================================================

Subroutine BM2                                                9/29/88

          Between labels 35 and 58
     Change:
          IF (ITG.NE.'  HIMAD' .OR. SDTGT(P).LE.0) GO TO 58
     To:
          IF (ITG.NE.'  HIMAD') GO TO 58
          IF (SDTGT(P).LE.0) GO TO 58

     Only a HIMAD has a SDTGT so to test for SDTGT without being sure
     you have a HIMAD is an error.
========================================================================

Function SYSFI                                                9/29/88

     Move:
          PFI=FITYP(P)
     To:  above line PAR10=XSEC(PFI)

     FITYP is not valid unless the passive unit is an aircraft
========================================================================

Subroutine INTCOR                                             9/29/88

          Below label 7
     Change:
          IF(AWAX(GL)) GO TO 9
     To:
          IF(AWAX(FI)) GO TO 9

     AWAX is a parameter of the fighter, not the interceptor
========================================================================
```

===

Subroutine LAUNCH   9/29/88

        Change:
            IF ((ITG.EQ.'   BOGEY').AND.(TYPSS etc.
        To:
            IF (ITG.EQ.'   BOGEY') THEN
                IF (TYPSS(AC).. etc.) GO TO 5
            ENDIF

            TYPSS is only valid for BOGEY aircraft, and should only be
        accessed by units which are BOGEY's.
===

Subroutine SPEC1   9/30/88

        In DATA TMP2 statement change the indexes from 5 to 6 for the
        following BM2 result indicators:
            4,10,21,22,23,24,25,26,35,36,37,41

            To correct a posting problem for BM2 RESINDs.
===

Subroutine KINCHK   9/30/88

        Change:
            GASN=GASNW(BI)
            IF (FROM.EQ.1) GASN=GASSO(FI)
        To:
            IF (FROM.EQ.1) THEN
                GASN=GASSO(FI)
            ELSE
                GASN=GASNW(BI)
            ENDIF

            The GASNW parameter is only valid if BI is an interceptor.
===

Subroutine CO2   9/30/88

            At the beginning
        Insert:
            NX=0

            Following IF (INDVAL.NE.0) GO TO 2
        Comment out:
            NX=NXFRM(P)

            The model was trying to access NXFRM for the AWACs, which is
        invalid.
===

===

Subroutine CO2   9/30/88

          Declare:
              LOGICAL RED

                  Line after label 2
          Change:
              IF (.NOT.ESC(P)) GO TO 16
          To:
              IF (RED(P)) THEN
                  IF (.NOT.ESC(P)) GO TO 16
              ENDIF

              ESC is a parameter only for red aircraft and should not be
          called otherwise.
===

Subroutine BI3   10/3/88

                  At label 87
          Change:
              87 IF (AWAX(FI)) GO.TO 846
          To:
              87 IF (.NOT.RSW) THEN
                      IF (AWAX(FI)) GO TO 846
                  ENDIF

              The AWAX parameter exists only for the blue fighter. The program
          must make sure it has a blue active unit before accessing it.
===

Subroutine BI5   10/3/88

                  At label 13
          Change:
              13 IF (.NOT.RBI .AND. AWAX(FI)) GO TO 98
          To:
              13 IF (.NOT.RBI) THEN
                      IF (AWAX(FI)) GO TO 98
                  ENDIF

              The AWAX parameter exists only for the blue fighter. The program
          must make sure it has a blue active unit before accessing it.
===

==

Subroutine CO4   10/3/88

            9 lines above label 1
    Delete:
        WFRST=W

            2 lines above that
    Change:
        WO=WFRST*(1.+.5*CORR)
    To:
        WFRST=WFRST*(1.+.5*CORR)

        The first line was a misprint, there is no variable W in this
    routine.
==

Subroutine BI5   10/3/88

            Below label 548
    Change:
        IF (AWAX(FI)) GO TO 556
    To:
        IF (.NOT.RBI) THEN
            IF (AWAX(FI)) GO TO 556
        ENDIF

        AWAX is only a parameter of the blue fighter and should not
    be accessed otherwise.
==

Subroutine BM2   10/3/88

            Above label 501
    Change:
        IF (AWAX(FI)) GO TO 555
    To:
        IF (.NOT.RED(P)) THEN
            IF (AWAX(FITYP(P))) GO TO 555
        ENDIF

        AWAX is only a parameter of the blue fighter and should not
    be accessed otherwise.
==

Subroutine BI3   10/3/88

            About 20 lines from the beginning
    Change:
        IF (.NOT.AWAX(FI) .AND. .NOT.RED(A)) CALL ZIND6(A,.FALSE.)
    To:
        IF (.NOT.RED(A)) THEN
            IF (.NOT.AWAX(FI)) CALL ZIND6(A,.FALSE.)
        ENIDF

        The AWAX parameter exists only for the blue fighter. The program
    must make sure it has a blue active unit before accessing it.
==

```
==========================================================================
```

Subroutine BOOST   10/3/88

        Declare:
            LOGICAL RED

                Before IF (IND8(A)) GO TO 2
        Insert:
            IF (RED(A)) THEN
                CRUSEV=FLTSPD(A)
            ELSE
                CRUSEV=SCRUS(FI)
            ENDIF

                A few lines below
        Delete:
            CRUSEV=SCRUS(FI)

                In the two IF test lines that follow
        Replace:
            SCRUS(FI)
        With:
            CRUSEV

            The aircraft cruising speed must be obtained differently depending
        upon whether the aircraft is blue or red. There is no SCRUS for red
        aircraft.
```
==========================================================================
```

CISCIAD.ORG file   10/3/88

        Add: to the BOGEY weapons deck
            $4 CURDV   0 0 24

            Change from F. Burns, SRS.
```
==========================================================================
```

Subroutine BM2   10/4/88

                A few lines below label 501
        Change:
            IF (ESC(NP)) GO TO 11
        To:
            IF (RED(NP)) THEN
                IF (ESC(NP)) GO TO 11
            ENDIF

            ESC is a parameter only for red aircraft and should not be
        called otherwise.
```
==========================================================================
```

```
=========================================================================
Subroutine BI5                                              10/4/88

        2 lines above label 35
Change:
    IF (.NOT.RBI .AND. ICAP(BI) .AND. IN123(BI).EQ.4) GO TO 818
To:
    IF (.NOT. RBI) THEN
        IF (ICAP(BI) .AND. IN123(BI).EQ.4) GO TO 818
    ENDIF

    ICAP is a parameter only for blue aircraft and should not be
called otherwise.

        Just below label 126
Change:
    CALL SCHEDL(BI,NBO2,T+DT22)
To:
    CALL EVFLIP(NBO2,NBO5,BI,T+DT22)

    BO2 events were getting scheduled improperly

=========================================================================
Subroutine BI4                                              10/7/88

        3 lines below label 7
Comment out:  the next 10 lines
        start with           IF (.NOT.RED(BI)) GO TO 20
        end with             + K.EQ.2) CALL EVFLIP(NBO2,NBO5,BI,DTB22(FI))

    BI4 was restarting the BO2 escort search event after a missile
launch, but it already gets started by another event.
=========================================================================
Subroutine DT1                                              10/19/88

        2 lines below label 200
Change:
    IF ((.NOT.DEAD(I)) .OR. (.NOT.OUTGM(I))) THEN
To:
    IF ((.NOT.DEAD(I)) .AND. (.NOT.OUTGM(I))) THEN


        2 lines below label 415
Change:
    IF (ITG.EQ.'   GENMIS') THEN
To:
    IF (ITG.EQ.'   BLUMIS') THEN


    Tracks should be dumped for each time step only if the unit is
alive AND in play (not engaged in a dogfight), not one OR the other.
The internal name for missiles is BLUMIS and not GENMIS.
=========================================================================
```

==

Subroutine BI3   10/20/88

        Change:
            446 IF (.NOT.(RSW.OR.RED(P))) GO TO 1319
        To:
            446 IF (.NOT.RSW .AND. .NOT.RED(P)) GO TO 1319

        This statement was incorrect. Red aircraft were being excluded
    from dogfighting. The intent of the statement is to keep blue from
    dogfighting blue.

            Above label 110
        Comment out:
            IF (.NOT.CPTR .AND.RSW) GO TO 110

        This statement keeps red escorts and interceptors from scheduling
    BI1 to implement maneuvers.
==

Subroutine BOX   10/21/88

        Declare:
            CHARACTER*8 TGNAME
            INTEGER CLASS

            Below IF (NTG.EQ.0) RETURN
        Insert:
            IF (TGNAME(CLASS(NTG)).EQ.' INCEPTB') THEN

            Before CALL ZTGT(A,0)
        Insert:
            ENDIF

        The ENGD parameter belongs to the blue interceptors and should not
    be accessed if the BOGEY has anything other than an interceptor for a
    target.
==

Subroutine BM2   10/21/88

        Declare:
            LOGICAL ILM

            After 30 CONTINUE
        Insert:
            ILM = ILLUM(NP)

            After label 34
        Change:
            IF (DEAP(NP).AND..NOT.FANDF(MT)) GO TO 13
        To:
            IF (DEAD(NP).OR..NOT.ILM).AND..NOT.FNDF) GO TO 13

        Subroutine BM2 was not checking to see if the aircraft that
    launched the missile was no longer tracking the target.
==

```
================================================================================
```

Subroutine BI3   10/21/88

       After label 103 and the comment line that follows
    Insert:
       CALL ZILLUM(A,.FLASE.)

       This is just to initialize the fighters illumination flag after
    an engagement is canceled.

```
================================================================================
```

Subroutine BI5   10/21/88

       Below label 200, after CALL ZATCKG(BI,.FALSE.)
    Insert:
       CALL ZIND9(BI,.FALSE.)
       CALL ZILLUM(BI,.FALSE.)
       CALL ZNFIRE(BI,0)

       Below 81 CONTINUE
    Insert:
       CALL ZILLUM(BI,.FALSE.)
       CALL ZATCKG(BI,.FALSE.)
       CALL ZIND9(BI,.FALSE.)
       CALL ZNFIRE(BI,0)

    Flags were not getting reset when a target was dropped.

```
================================================================================
```

Subroutine BI3   10/21/88

       About 10 lines above label 442
    Move:
       NOOT = ENGD(JP) - NFR
    To: below statement
       IF (.NOT.RSW) GO TO 442

    The ENGD parameter is being accessed by units which do not have
    that parameter. Red aircraft are the only ones who can access this.

```
================================================================================
```

Subroutine USRCOM   10/25/88

    Declare:
       COMMON /MSMTRX/ MSHTSR(20,20,3),NOSHD(3)

       After NBOG1 = 0
    Insert:
       C *** BO5 ***
           DO 66 L=1,3
      66 NOSHD(L)=0

    The NOSHD array was not getting initialized between replications.

```
================================================================================
```

```
=================================================================================
```

Subroutine BI3   10/26/88

        Declare:
            LOGICAL RDSCH

                Above comment IF BLUE FINDS BLUE TARGET IS WITHIN VISDR, DROP IT
        Insert:
            SWE = .FALSE.
            IF (TGT(P).EQ.A).AND.(ATCKG(P).OR.IND9(P))) SWE = .TRUE.
            IF (.NOT.RSW) THEN
                IF (AWAX(FI)) GO TO 1319
            ENDIF

                9 lines below label 1319
        Delete:
            SWE = .FALSE.

        Change:
            87 IF (AWAX(FI)) GO TO 846
        To:
                IF (.NOT.RSW) THEN
                    IF (AWAX(FI)) GO TO 846
                ENDIF

                and move this new block up 3 lines
        To: above
            IF ((MM1.NE.0).OR.(MM2.NE.0)) GO TO 88

            These changes correct the setting of the SWE flag and correct the
        logic for accessing parameters for AWAX.

                Above label 88
        Change:
            IF ((MM1.NE.0).OR.(MM2.NE.0)) GO TO 88
        To:
            IF (MM1+MM2 .GT. MINMSL) GO TO 88

            Uses COMIL input to check for minimum missiles rather than 0
        for fighters or escorts to return to base or go home.

                On the next line
        Change:
            IF (ILLUM(A)) GO TO 87
        To:
            IF (ILLUM(A)) GO TO 13

            Avoids aircraft checking AWACs flag when not applicable.
```

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine BI3                    Continued                    10/26/88

        Below label 88
    Insert:
        IF (.NOT.MLTGT(FI) .AND. SWE) GO TO 888

        On the next line
    Change:
        IF ((NFR.EQ.1).AND.(ILLUM(A).OR.(TGT(P).EQ.A))) GO TO 888
    To:
        IF ((NFR.EQ.1).AND.SWE) GO TO 888

        Avoids switching targets if aircraft does not have the capability
    or if he is a single aircraft and is currently engaged.

        About 12 lines below label 88
    Change:
        IF (RT.GT.DT) GO TO 99
    To:
        IF (RT.GE.DT) GO TO 99

        Changed by D. Michael, AFOTEC, 1986.

        On the line below
    Change:
        PAR2 = 1
    To:
        PAR2 = 0
    Insert:  afterwards
        IF (RDSCH(FI)) PAR2 = 1

        Search routing SYSFI uses variable PAR2 to indicate whether the
    fighter has its own radar search capability.

        About 5 lines below
    Delete:
        ITGCMP = 0

        About 12 lines below that
    Delete:
        ITGCMP = 1

        Variable ITGCMP does not appear to be used.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Subroutine BI3                    continued                    10/26/88

```
            4 lines below label 1505
    Change:
            IF (A.EQ TGT(PASCU(1))) GO TO 1318
    To:
            IF (A.EQ.TGT(PASCU(1))) GO TO 1317

            A few lines below that
    Change:
            IF (ILLUM(A).OR..NOT.ATCKG(A)) GO TO 888
    To:
            IF (ILLUM(A).OR.ATCKG(A)) GO TO 888

            On the next line down
    Delete:
            IF (ITGCMP.EQ.1) GO TO 1318

            2 lines above label 1515
    Change:
            IF (TPASCU.GT.TP) GO TO 1318
    To:
            IF (TPASCU.GT.TP) GO TO 1317

            Below label 1517
    Insert:
            PASCU(1) = P

            Below label 8899
    Change:
            IF (ISW.EQ.1) GO TO 13
    To:
            IF (ISW.EQ.1) GO TO 105

            Before label 1318
    Insert:
            1317 IF (ILLUM(A)) THEN
                    CALL CANCEL(A,NBI4)
                    CALL ZATCKG(A,.FALSE.)
                    CALL ZIND9(A,.TRUE.)
                    GO TO 888
                ENDIF

            3 lines before label 888
    Insert:
            CALL ZINDET(A,.FALSE.)
```

Corrects inconsistencies in Subroutine BI3 code between CISCIAD
and CIAD. Changes made to CIAD by D. Michael, AFOTEC, 1986.
==

```
=========================================================================
Function SYSFI                                                   10/26/88

        Delete:
            LOGICAL RDSCH

                16 lines below label 102
        Change:
            IF ((TGT(P).EQ.BI).AND.RDSCH(FI)) GO TO 6
        To:
            IF ((TGT(P).EQ.BI).AND.PAR2.NE.0) GO TO 6

                2 lines above label 2
        Change:
            IF (RDSCH(FI).AND.PAR2.NE.0) GO TO 3
        To:
            IF (PAR2.NE.0) GO TO 3

                2 Lines after label 10
        Delete:
            IF (EVTIND(BI,NBI3).EQ.0) GO TO 13
        Insert:
            IF (.NOT.ICAP(BI).OR..NOT.CPINT(FI)) GO TO 13

            Changes made to CIAD by D. Michael, AFOTEC, 1986.
=========================================================================

Subroutine BI2                                                   10/26/88

        Declare:
            LOGICAL RDSCH

                At the beginning, above AMO = T-INT(T/DTR)*DTR
        Insert:
            IF (.NOT.RDSCH(FI)) GO TO 10

                Down a few lines after the comments
        Insert:
            10 CONTINUE
               IF (EVTIND(BI,NBI4).NE.0) GO TO 6

            This is to facilitate earlier changes made to BI3 and SYSFI
        regarding the way PAR2 is set and used.
=========================================================================

Subroutine BI2                                                   10/26/88

                5 lines above label 4 before line LN=1
        Insert.
            CALL ZMODE(BI,2.0)

            Changes made to CIAD by D. Michael, AFOTEC, 1986.
=========================================================================
```

```
■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
```

Subroutine EIS   10/28/88

```
          2 lines above label 208
     Change:
          IF (EVTIND(BI,NBI3).EQ.0) GO TO 208
     To:
          IF (EVTIND(BI,NBI3).NE.0) GO TO 32
     Delete:  the next line
          IF (INDVAL.NE.0) GO TO 32

          6 lines below label 208
     Change:
          IF ((EVTIND(BI,NBI2).EQ.0).AND.(INDVAL.EQ.0).AND..NOT.SWG)
        +   CALL SCHEDL(BI,NBI2,T+DTB22(FI))
     To:
          IF ((EVTIND(BI,NBI2).EQ.0).AND.(EVTIND(BI,NBI3).EQ.0).AND..NOT.SWG)
        +   CALL SCHEDL(BI,NBI2,T+DTB22(FI))

          Subroutine BI2 was incorrectly being scheduled.
```

```
■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■
```

Subroutine BI2   10/31/88

```
     Declare:
          LOGICAL RED

          2 lines above label 11
     Delete:
          IF (EVTIND(BI,NBI4).NE.0) GO TO 6

          2 lines below 881
     Delete:
          RESIND(2) = 2
          ACTCU(1) = BI
          CALL EVNOUT(NBI2,2)

          At label 4
     Change:
          RESIND(1)=1
     To:
          ACTCU(1) = BI
          IF (RED(PASCU(1))) THEN
             RESIND(1) = 1
             CALL EVNOUT(NBI2,1)
          ELSE
             RESIND(1) = 2
             CALL EVNOUT(NBI2,2)
          ENDIF
```

- -

- -

Subroutine BI2   continued   10/31/88

             3 lines below label 888
        Delete:
             ACTCU(1) = BI
             CALL EVNOUT(NBI2,1)

             This is part of the attempt to get the intercept control logic
        working the same in bo'h models. This cleared up a situation where
        RESINDs were being posted twice.
==

Subroutine BI3   11/2/88

        Add:
             COMMON /TCHK/ XCHK,YCHK,ZCHK,RCOR2

             About 10 lines below label 88
        Insert: after PAR1=A
             RCOR2 = RCORR(NCO)
             XCHK = XB
             YCH2 = YB
             ZCHK = ZB

             Just after label 444
        Insert: after YB=Y(P)
             ZB = H(P)

             Changes made to CIAD by D. Michael, AFOTEC, 1986.
==

Function SYSFI   11/3/88

             After label 13
        Insert:
             IF (TGT(BI).NE.0 .AND. TGT(BI).NE.P) THEN
                RCHK = (XCHK-X(P))**2 + (YCHK-Y(P))**2 + (ZCHK-H(P))**2
                IF (RCHK.LE.RCOR2) RETURN
             ENDIF
        Delete:
             IF (MMIS1(BI).GT.0) GO TO 14
             PAR2 = 0
             GO TO 5

             Changes made to CIAD by D. Michael, AFOTEC, 1986.
==

```
=============================================================================
Subroutine BI3                                                      11/3/88

      Declare:
          LOGICAL SWEPAS

              Below label 1505, after ISW=0
      Insert:
          SWEPAS = .FALSE.
      Change:
          IF (A.EQ.TGT(PASCU(1))) THEN
              IF (ATCKG(PASCU(1)).OR.IND9(PASCU(1))) SWEPAS = .TRUE.
              IF (RED(PASCU(1)) THEN
                  IF (ESC(PASCU(1)).AND.R(A,PASCU(1)).LT.VISR) SWEPAS = .TRUE.
              ENDIF
          ENDIF
          IF (SWEPAS) GO TO 1317

          Interceptors were switching targets too often.  They should only
      switch to the new target if they are threatened by a missile launch or
      the new target is an escort within visual range.  Changed by D. Michael,
      AFOTEC, 1986.
=============================================================================
Subroutine BI3                                                      11/4/88

      Delete:
          CHARACTER*8 TGNAME,ITG

              At the beginning
      Delete:
          IF (P.EQ.0) ITG = TGNAME(CLASS(P))

          The variables ITG and TGNAME are never used in BI3.

              7 lines below label 103
      Insert:
          CALL ZIND9(A,.FALSE.)
          CALL ZNFIRE(A,0)
      Move:  from about 10 lines futher down, up to where this new code is
          CALL ZINDET(A,.FALSE.)

          These changes were made to coordinate with the CIAD model.  They
      are present just to be sure that these parameters are initialized after
      an engagement is canceled.

              8 lines above label 442
      Delete:
          ZENGD(JP,0)

          This statement does not make any sense here.  ENGD is set again
      two lines down from here in the code.
```

- -

Subroutine BI3   continued   11/4/88

          5 lines below label 444, after YA=Y(A)
Insert:
      IF (AWAX(FI)) GO TO 445

      AWAX aircraft do not need to go through this section of code.

          Below C *** IF BLUE FINDS BLUE TARGET...(above label 446)
Change:
      IF (RAP.GT.VISR) GO TO 446
To:
      IF (RAP.GT.VISR) THEN
      CALL ZINDET(A,.FALSE.)
      GO TO 1319
      ENDIF

      Model was allowing aircraft, which were not within visual range
of one another, the opportunity to dogfight. This is incorrect.

Delete:
      446 IF (.NOT.RSW.AND..NOT.RED(P)) GO TO 1319
Label: the next line 446 as follows
      446 IF (CPTR) GO TO 1319

      The model is testing for a blue vs blue engagement, but a
situation such as this will not reach this part of the code so
it is unnecessary.

          2 lines above label 319
Change:
      IF (PDET(FI).GT. .5 .AND. RAP.LT.VISR) VR=.TRUE.
To:
      VR = .TRUE.

      Object of this section of code is to set VR to true if it is
not already true at this point. RAP is always less than VISR here
or else the program would have branched over this section to label 1319.

          2 lines below label 319
Change:
      IF (.NOT.VR .OR. .NOT. INDET(P)) GO TO 1319
To:
      IF (.NOT. INDET(P)) GO TO 1319

      Since VR will always be true at this part of the code, there
is no need to test it in the statement.

- -

- -

      Below label 1319
Delete:
```
      GAMC=SPXA*SPXP + SPYA*SPYP + SPZA*SPZP
```

      A few lines further down
Delete:
```
      SCRR=SA*(RDOTVA-RDOTVP*GAMC)
      IF (ABS(SCRR).LT. .01) SCRR=.01
      SVP=SQRT(ABS(1.-RDOTVP**2))
      IF (ABS(SVP).LT. .01) SVP=.01
      SPP=SQRT(S(A)**2-W(A)**2)
      IF (SPP.LT. 1.) SPP=1.
```

These variables do not exist in COMMONs and are not used for any reason in BI3.

      Below label 88
Delete: first occurrence only, after NPPP=TGT(A)
```
      ISW=1
```

      3 lines below label 1505
Change:
```
      IF (A.EQ.TGT(P)) GO TO 1515
```
To:
```
      IF (SWE) GO TO 1515
```

Changes made to CIAD by D. Michael, AFOTEC, 1986.

      2 lines below label 99
Change:
```
      IF (RSW) GO TO 150
```
To:
```
      IF (SWE) GO TO 150
```
Delete:
```
      ESCFLG = .TRUE.
      IF (RED(P)) ESCFLG = ESC(P)
      IF (ESCFLG.AND.(RAP).LT.VISR)) GO TO 150
      SWE = .TRUE.
```

      3 lines below label 824
Change:
```
      CALL ZIND6(A,.TRUE.)
```
To:
```
      CALL ZIND6(A,.FALSE.)
```

- -

- -

Subroutine BI3   Continued   11/4/88

```
            6 lines below label 856
      Change:
            IF (IFLG.EQ.0) GO TO 87
      To:
            IF (IFLG.EQ.0) GO TO 105

            Next line down
      Change:
            IF (IFLG.EQ.2) GO 828
      To:
            IF (IFLG.EQ.2) GO TO 827

            Next line down
      Change:
            IF (IND6(A)) GO TO 105
      To:
            IF (IND6(A)) GO TO 827

            At label 827
      Change:
            827 CALL SCHEDL(A,NBI3,T+DT)
                CALL ZEVIND(A,1,3)
                CALL BSORT(A)
                GO TO 102
      To:
            827 CALL ZMODE(A,2.0)
                CALL ZICAP(A,.FALSE.)
                CALL ZTGT(A,P)
                CALL ZNAGRS(P,NAGRS(P)+1)

            Changes made to CIAD by D. Michael, AFOTEC, 1986.
```
===

APPENDIX F

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GLOSSARY

1. ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

ADM2	Air Defense Models Modification Study
ADS	air defense suppression
AFOTEC	US Air Force Operational Test and Evaluation Center
ANSI	American National Standards Institute
AWACS	Airborne Warning and Control System
CAA	US Army Concepts Analysis Agency
CAP	combat air patrol
COMIL	COMO Input Language
COMO	computer modeling system
C3	command, control, and communications
ECM	electronic countermeasures
ESJ	escort jammer
FLOT	forward line of own troops
GRC	General Research Corporation
HIMAD	high-to-medium altitude air defense
IFF	identification, friend or foe
km	kilometer(s)
MOE	measure(s) of effectiveness
SHAPE	Supreme Headquarters Allied Powers, Europe
SHORAD	short-range air defense
SOJ	standoff jammer
SSJ	self-screening jammer
STC	SHAPE Technical Centre
TRAC-WSMR	US Army TRADOC Analysis Command - White Sands Missile Range

TRADOC	Training and Doctrine Command
VAX 8600	Digital Equipment Corporation minicomputer

2. MODELS, SIMULATIONS, AND ROUTINES

CIAD	COMO Integrated Air Defense Model
CISCIAD	Combat Identification Systems COMO Integrated Air Defense Model